

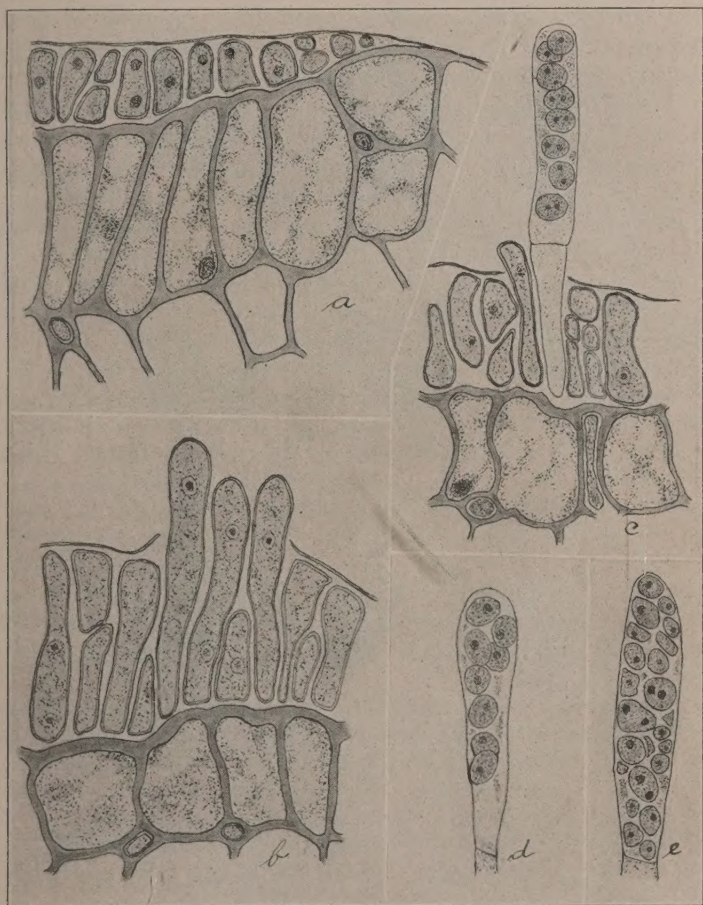


FIG. 1. Sections through infected plums: a, Invasion of fungus under the cuticle of the skin. b, Fungus breaking through cuticle. c, d, and e, Spore sacs in different stages of spore formation. All magnified 1110 times.

causing these two plum pockets are closely related, similar in appearance, and cause similar symptoms. The latter does not occur in Montana at this time so far as we know. This discussion will, therefore, be confined chiefly to the former disease.

When this fungus attacks the fruit it does not at once grow throughout the flesh but is chiefly confined to the skin into which it forces its way (fig. 1 a). A small portion of it, however, goes deeper into the fruit. A few weeks later the fungus breaks out through the skin, producing enormous numbers of spore sacs over the entire surface, and each of these forms quite regularly eight spores. As reported by various authors these spores later divide into numerous smaller ones. These same authors report that the fungus lives over winter in the fruit-bearing twigs. We have not made an exhaustive study of this phase of the subject, but we are convinced that most of the twigs bearing diseased fruits do not harbor the fungus over winter, and most of the plums are infected by spores and not by direct extension of a fungus from the twigs bearing them. Our success in controlling the disease by spraying would support these microscopical findings. The fungus has been described by several workers, but they have not made clear its full life history. So far as known only one crop of spores is formed, and these are distributed in midsummer; but at this time the young, healthy fruits seem no longer susceptible to attack. No new fruit infections are known to occur from this time until the next blooming period of the trees.

Symptoms.—A week or two after the blossoms wither, when the fruits are one-fourth to one-half inch in diameter, small whitish spots appear on them, usually one to three on each. These are greenish-white in color, much elevated, and very spongy in texture (fig. 2). They enlarge rapidly until usually the entire plum is involved. At this time the stone and seed are only slightly developed and become broken away from the ducts or veins that supply them with water and food and consequently shrivel and disappear. The infected fruits enlarge rapidly and become spongy and then hollow (fig. 3), hence the names "plum pockets," "pocket plums," "bladder plums," and "fools." When full-grown they are three or four times the size of normal plums and leathery in texture. (Fig. 4.) They drop before healthy fruit begins to ripen.

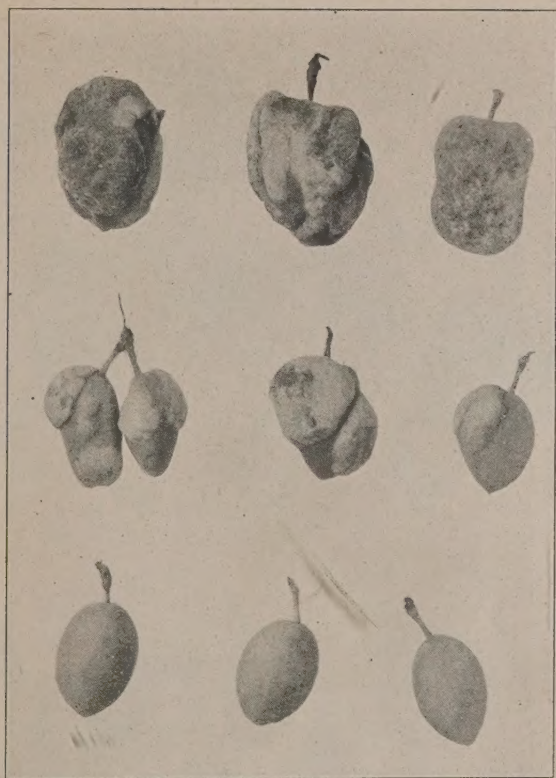


FIG. 2. Healthy and diseased plums, not fully developed, for comparison. Natural size.

Damage done.—Plum pocket is extremely common on Americana plums in central and eastern Montana, and in many other places in the Missouri and Mississippi valleys. It usually starts on a few trees in the orchard and gradually spreads to others. When a tree becomes infected it continues to bear diseased plums year after year if left untreated. When the disease has become well established in an orchard it is not unusual to find affected fruits on nearly every tree, and on the worst ones 50 to 90 per cent of the fruits are diseased

every year. When a heavy crop is set and the disease is not too severe, it will occasionally result in a proper thinning of the fruit, but this combination is uncommon. We know of entire orchards of good bearing trees having been removed because so few healthy fruits were obtained from them. These orchards were not large, but they were the pioneer test orchards that should have determined whether or not it will be profitable to grow this fruit. Indeed we know of very few plum orchards or even wild thickets in this State east of the continental divide that are free from plum pocket.

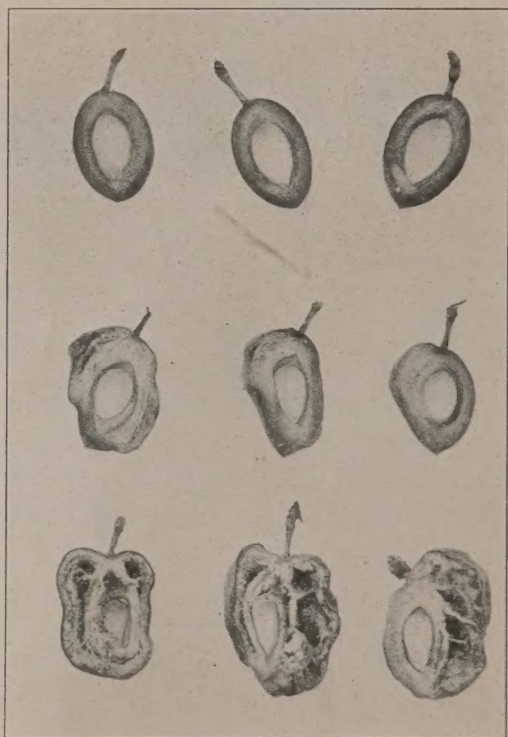


FIG. 3. Internal view of young healthy and diseased plums, showing spongy structure. Natural size.



FIG. 4. Well developed pocket plum and young healthy ones for comparison in size. Two-thirds natural size.



FIG. 5. Twig showing leaf galls and pocket plums. Half natural size.

LEAF GALL

In our experiments for the control of plum pocket we found leaf gall so abundant on some of the trees that it was likely to seriously complicate the results.

Cause.—These leaf galls are caused by a mite which hibernates under the bud scales. When the buds open these mites crawl forth, seeking the tender young leaves, which they puncture, forming pimples that soon develop into galls.

Appearance.—The galls when fully developed are one-fourth to one-half inch long and one-eighth inch or less in diameter and strongly tinged with red. They are hollow, and the mites live inside. Most of the galls protrude from the upper side of the leaf, either scattered or in dense tufts. (Fig. 5.)

Damage done.—These galls do not kill the leaves outright, but if numerous they seriously interfere with normal functions. Often they are so numerous as to distort a large portion of the leaf surface of the tree.

LEAF CURL

Many of the plum trees in the Yellowstone Valley are more or less affected with a leaf curl which is sometimes mistaken for plum pocket on the leaves. This disease has become so abundant in certain trees that considerable damage is done, but for the most part it is scattered, though steadily increasing in prevalence.

CONTROL EXPERIMENTS

In the spring of 1913 the authors, in response to repeated complaints that plum pockets and leaf-gall mites were making plum growing unprofitable, began work intended primarily to find a preventive for plum pocket but incidentally including leaf gall and leaf curl.

Plum pocket.—Some attempts have been made to control, by spraying, the form of plum pocket that attacks European plums, but until recently none have been successful. In a very recent paper Stakman and Tolaas* have shown that while this plum pocket cannot be perfectly controlled by a single season's spraying, yet the cumulative effect of spraying every year will in time practically eliminate it even from badly infested trees.

*Minnesota Horticulturist. May, 1918.



FIG. 6. Twig affected with leaf curl. Two-thirds natural size.

We find no records of spraying experiments for the form of pocket that attacks the Americana plum.

Our experiments were conducted in three orchards near Billings, Montana, during the years 1913 to 1917, inclusive. These orchards contained a mixture of native wild plum and several cultivated varieties of it. So far as our observations have gone Wolf and Wyant have proven rather susceptible to plum pocket, while DeSoto and Hawkeye were much more resistant.

As plum foliage is easily injured by spray mixtures we made no attempt to use Bordeaux mixture but started out with self-boiled lime sulphur—8 pounds lime and 8 pounds sulphur to 50 gallons of water. The lime was slaked with hot water, and as soon as it was boiling actively the sulphur (flowers) was added. The mixture was stirred until boiling had nearly ceased, after which it was allowed to stand for ten minutes; then enough cold water was added to make a total of 50 gallons. Later, dilute factory-boiled lime-sulphur was used. This was the Hellgate brand manufactured in Missoula, Montana, and testing 28° Baume. It was diluted 1 part to 50 parts of water.

The fungicide was applied during the years 1913-1915 with a Meyers barrel pump and in 1916 and 1917 with a Morrell and Morley "Eclipse No. 4," maintaining a pressure of about 50 pounds. The hose was fitted with a Bordeaux nozzle.

In 1913 a late spring frost destroyed the crop almost completely.

In 1914 frost destroyed the greater part of the crop, but enough remained to give some results indicating that the disease could be controlled, to some extent at least, by spraying.

In 1915 conditions were more favorable and the results obtained were quite satisfactory. None of the trees were sprayed in a dormant condition. Trees sprayed once "in the pink," i. e., just as the flower buds were beginning to open, produced only a small fraction of one per cent of diseased fruit. Spraying while the petals were falling gave benefit also. Unsprayed trees bore upwards of fifty per cent of pocket plums.

To determine whether the effects of spraying extend beyond one year a set of trees sprayed with self-boiled lime-sulphur in 1915 was left unsprayed in 1916 but notes were taken both years on the prevalence of the disease.

The season of 1916 was not so favorable to the disease as that of 1915 and it was much less prevalent on unsprayed trees. Also the crop was lighter. The results indicated, however, that the effects of spraying last only for one season.

In 1916 it was decided to try both self-boiled lime-sulphur and the factory-boiled product (28° Baume diluted 1 to 50), hoping that the latter would prove equally effective, as its preparation is much simpler for the orchardist. It had also been observed that so many infections were visible within two weeks from the time the petals

wither that the later sprays were worthless. Consequently only two applications were given.

The control by spraying with self-boiled lime-sulphur was absolutely perfect. Not a single diseased plum could be found on a sprayed tree.

The factory-boiled lime-sulphur likewise gave perfect control while the six unsprayed check trees with a total of 714 plums had 72 of them diseased, or an average of 10 per cent. As already noted 1916 was a poor year for both plum pocket and plums.

If 1916 was an unfavorable year for plum pocket, 1917 was quite the reverse, both for the disease and for spraying. Rains were frequent throughout the blooming period of the plum trees. The "dormant" and the "pink" sprays were not immediately followed by rains but there was some precipitation on each of the three days immediately following the "petal" spray.

It had been decided from previous work that the disease could be controlled by a single application of lime-sulphur, and the work of 1917 was principally to confirm this belief and to determine which is the best time for spraying. Consequently each tree was sprayed but once—different groups on different dates.

TABLE I.—SHOWING CONTROL OF PLUM POCKET WITH DILUTE COMMERCIAL LIME-SULPHUR UNDER UNFAVORABLE CONDITIONS, i. e., A RAINY PERIOD

Tree No.	When sprayed (1917)			Results	
	I Dormant	II Pink	III Petal	Total No. fruits	Per cent diseased
1	May 8	.....	.....	304	1.3
2	May 8	.....	.....	* .....	
3	May 8	.....	.....	110	6.4
4	May 8	.....	.....	91	7.7
5	.....	May 16	.....	100	25.
6	.....	May 16	.....	200	13.
7	.....	May 16	.....	1400	.8
8	.....	May 16	.....	70	2.9
9	.....	.....	May 27	700	80.0
10	.....	.....	May 27	400	85.0
11	.....	.....	May 27	450	85.0
12	.....	.....	May 27	*	
13	Unsprayed			1800	46.0

*Label lost.

Table I shows what can be done to control plum pocket under much less favorable conditions than those during the preceding years of the experiment. The results were by no means perfect, and yet much benefit was derived from the first and the second sprays. The third application, made when most of the petals were withering, gave little or no benefit either because it was too late or because it was washed off by rain.

From our experiments, extending through the last five years, we feel certain that the plum pocket attacking Americana plums can be controlled without serious difficulty, excepting, perhaps, in regions or seasons having very frequent rains through the blooming period. To what extent the same treatment will control the form attacking European varieties is problematic. The two fungi are very closely related and appear to have very similar life histories. It is probable that in both forms some fruits are infected by the extension of the fungus from the twigs diseased last year and others by spores alighting on the surface. There seems little reason to suppose that the infection from the diseased twigs can be controlled by spraying, nor, on the other hand, that the infection by spores can not be so controlled. It seems fair to expect, then, that the form on European varieties can be controlled by spraying to whatever extent the spores are responsible for fruit infections, and the work of Stakman and Tolaas, reviewed on page 158, supports this expectation. We have had no opportunity in this State to test the applicability of this hypothesis.

Leaf-gall mite.—Leaf galls were so prevalent on many of the trees used in experiments for the control of plum pocket that it was thought best to devise some means of reducing them. Accordingly in 1914 all the trees used in that season's work were given a late "dormant" spray of lime-sulphur, 28° Baume, diluted 1 to 6. Only a small number of galls appeared on any of these trees. In 1915 it was noted that none of the trees that were sprayed early developed many galls, while the check tree and many others in the orchard were badly infested. The results in 1916 were similar.

These tests indicated that if trees are sprayed in the dormant condition or in the pink, even with dilute lime-sulphur, the number of galls is greatly reduced, but as no records had been made the previous season on the prevalence of the galls on these trees and as some of them undoubtedly were freer from it than others, a more

definite experiment on a small scale was planned. In the summer of 1916 a number of plum trees on which the galls were very abundant were selected and labeled. In 1917 these were sprayed with Hellgate lime-sulphur, 28° Baume, diluted 1 to 50. The results are shown in Table II.

TABLE II.—SHOWING CONTROL OF LEAF MITE WITH DILUTE FACTORY-BOILED LIME-SULPHUR

Tree No.	When sprayed (1917)		Results
	I Dormant	II Pink	Prevalence of mite galls
1	May 8	.....	Very few
2	May 8	.....	Very few
3	May 8	.....	None
4	.....	May 16	Abundant
5	.....	May 16	Very abundant
6	.....	May 16	Very abundant
7	.....	May 16	Very abundant
8	Unsprayed		Very abundant
9	Unsprayed		Very abundant

From this table we can see that the "dormant" spray, even quite dilute, reduced the mite to such an extent that little damage was done, but that the "pink" spray had little effect upon it. In 1915 and 1916 the "pink" spray gave good control but the "petal" spray much poorer.

Plum leaf curl.—In the summer of 1916 a number of trees showing leaf curl and twig distortions (fig. 6) were selected and labeled. In the spring they were sprayed with Hellgate lime-sulphur, 28° Baume, diluted 1 to 50, and each tree was given a single application, three of them in the dormant condition, two of them in the pink condition, and three of them when the petals were withering. No apparent benefit was derived in the control of the leaf curl. This was not surprising, however, as the fungus quite regularly hibernates in the twigs and the spread by spores to healthy twigs is very slow.

CONCLUSIONS

1. The native plum and varieties derived from it are about the only ones that can be grown successfully in central and eastern Montana.

2. These plums are highly prized and sell for good prices in Montana markets.

3. The growing of these plums has been made unprofitable by plum pocket and leaf-gall mite.

4. The plum pocket can be very well controlled by spraying with lime-sulphur,—either self-boiled 8-8-50, or factory-boiled 28° Baume, diluted 1 to 50, or 32° Baume, diluted 1 to 60.

5. Only a single application is necessary, and this may be given at any time from a late dormant condition to the time the flowers begin to open.

6. The effects of spraying appear not to extend over more than one season.

7. Both microscopical examination and the results of spraying indicate that while the fungus may live over in some twigs most of the fruits are infected by spores.

8. The leaf-gall mite of plum is easily controlled by spraying with dilute lime-sulphur while the trees are still dormant, and in some seasons when the buds are in the pink, but after the petals fall it is too late to get the best results.

9. Spraying is not likely to control the leaf-curl of plum.

RECOMMENDATIONS

1. Now that a simple practical way has been discovered for the control of this plum pocket and the leaf-gall mite, the growing of Americana plums should be encouraged in eastern Montana, especially in the valleys of the Yellowstone River and its tributaries. Small home orchards of this fruit should become rather common but the extent to which it may be raised commercially remains to be determined.

2. Limited observations indicate that the better strains of the wild plum, and DeSoto, Hawkeye, Wolf, and Wyant, derived from it, are well suited to the Yellowstone Valley.

3. To control plum pocket or leaf-gall mite or both, give one application of lime-sulphur (28° Baume, diluted 1 to 50) just before the fruit buds open. If rain follows within two days after spraying, repeat the operation.

